

**WHAT IS CLAIMED IS:**

1                   1. A mobile communication device comprising:  
 2                   a plurality of signal detectors, each signal detector configured to provide a  
 3                   respective detected signal having a desired component plus an undesired component; and  
 4                   a noise suppression unit operatively coupled to the plurality of signal  
 5                   detectors and configured to receive and digitally process the plurality of detected signals  
 6                   from the plurality of signal detectors to provide an output signal having substantially the  
 7                   desired component and large portion of the undesired component removed.

1                   2. The device of claim 1, further comprising:  
 2                   a first beam forming unit operatively coupled to the plurality of signal  
 3                   detectors and configured to process the plurality of detected signals to form a first signal  
 4                   having the desired component plus a portion of the undesired component; and  
 5                   a second beam forming unit operatively coupled to the plurality of signal  
 6                   detectors and configured to process the plurality of detected signals to form a second  
 7                   signal having a large portion of the undesired component, and  
 8                   wherein the noise suppression unit is operatively coupled to the first and  
 9                   second beam forming units and configured to receive and digitally process the first and  
 10                  second signals to provide the output signal.

1                   3. The device of claim 2, wherein the first and second beam forming units  
 2                   and the noise suppression unit are implemented within a digital signal processor (DSP).

1                   4. The device of claim 1, wherein the signal detectors are microphones.

1                   5. The device of claim 4 and comprising two microphones.

1                   6. The device of claim 2, wherein the noise suppression unit is operative  
 2                   to remove the undesired component in the first signal using spectrum modification.

1                   7. The device of claim 2, wherein the noise suppression unit digitally  
 2                   processes the first and second signals in the frequency domain.

1 8. The device of claim 7, wherein the noise suppression unit includes  
2 a first transformer coupled to the first beam forming unit and configured to  
3 receive and transform the first signal into a first transformed signal, and  
4 a second transformer coupled to the second beam forming unit and  
5 configured to receive and transform the second signal into a second transformed signal.

1 9. The device of claim 8, wherein the noise suppression unit further  
2 includes  
3 a multiplier configured to receive and scale the first transformed signal  
4 with a set of coefficients.

1 10. The device of claim 9, wherein the set of coefficients are derived  
2 based on spectrum subtraction.

1 11. The device of claim 9, wherein the noise suppression unit further  
2 includes  
3 a noise spectrum estimator operative to receive and process the second  
4 transformed signal to provide a noise spectrum estimate, and  
5 a gain calculation unit operative to receive the first transformed signal and  
6 the noise spectrum estimate and provides the set of coefficients for the multiplier.

1 12. The device of claim 11, wherein the noise spectrum estimator is  
2 operative to provide time-varying noise spectrum estimate.

1 13. The device of claim 2, wherein the noise suppression unit includes  
2 an activity detector configured to receive the first and second signals and  
3 provide a control signal indicative of active time periods whereby the first signal includes  
4 predominantly the desired component.

1 14. The device of claim 13, wherein the first and second beam forming  
2 units are adjusted based on the control signal from the activity detector.

1 15. The device of claim 1 and operative to receive and process far-field  
2 signals.

1 16. The device of claim 1 and operative to receive and process near-field  
2 signals.

1 17. The device of claim 2, wherein each of the first and second beam  
2 forming units includes  
3 at least one adaptive filter, each adaptive filter operative to receive and  
4 process a signal from a respective signal detector to provide a corresponding filtered  
5 signal.

1 18. The device of claim 17, wherein each adaptive filter implements a  
2 least mean square (LMS) algorithm.

1 19. The device of claim 1, wherein the device is a cellular phone.

1 20. A wireless communication device comprising:  
2 at least two microphones, each microphone configured to detect and  
3 provide a respective signal having a desired component plus an undesired component; and  
4 a signal processor coupled to the at least two microphones and configured  
5 to receive and digitally process the detected signals from the microphones to provide an  
6 output signal having substantially the desired component and large portion of the  
7 undesired component removed.

1 21. The device of claim 20, wherein the signal processor digitally  
2 processes the detected signals in the frequency domain.

1 22. The device of claim 20, wherein the signal processor digitally  
2 processes the detected signals in the time domain.

1 23. The device of claim 20, wherein the signal processor is operative to  
2 remove the undesired component from the output signal using spectrum subtraction.

1 24. The device of claim 20, wherein the signal processor is further  
2 configured to process the detected signals to provide a first signal having the desired

3 component plus a portion of the undesired component and a second signal having a large  
4 portion of the undesired component.

1 25. The device of claim 20, wherein the signal processor is operative to  
2 process far-field signals or near-field signals.

1 26. The device of claim 20, wherein the microphones are placed close to  
2 each other relative to a wave-length of sound and not in an end-fire type of configuration.

1 27. A method for suppressing noise in a wireless communication device,  
2 comprising:  
3 detecting at least two signals via respective signal detectors, wherein each  
4 detected signal includes a desired component plus an undesired component;  
5 deriving, from the detected signals, a first signal having substantially the  
6 desired component plus a portion of the undesired component;  
7 deriving, from the detected signals, a second signal having a large portion  
8 of the undesired component; and  
9 digitally processing the first and second signals to provide an output signal  
10 having substantially the desired component and large portion of the undesired component  
11 removed.

1 28. The method of claim 27, wherein the digital processing includes  
2 removing the undesired component from the output signal using spectrum  
3 subtraction.

1 29. The method of claim 28, wherein the digital processing further  
2 includes  
3 estimating a noise spectrum of the undesired component based on the  
4 second signal,  
5 deriving a set of coefficients based on spectrum subtraction, and  
6 scaling transformed representation of the first signal based on the set of  
7 coefficients.

- 1                    30. The method of claim 29, wherein the digital processing provides time-
- 2    varying noise spectrum estimate.